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SANDS (H.B.)

ON THE USE
OF THE
PLASTER-OF-PARIS BANDAGE
IN THE
TREATMENT OF FRACTURE,
ESPECIALLY
FRACTURE OF THE FEMUR.

BY

HENRY B. SANDS, M. D.,

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THE BELLEVUE HOSPITAL, ETC.

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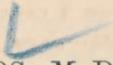
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THE treatment of fracture is a subject full of interest to the surgeon, on account of the responsibility which it involves, and the difficulty which is encountered, in many cases, of bringing about a satisfactory result. Excluding such instances of failure as depend upon careless or unskilful management, it is a notorious fact that, even in the most practised hands, a perfect restoration of the injured parts to their normal state is an exception to the rule. The experienced and cautious surgeon will not guarantee to the patient the completeness of cure which he naturally and almost invariably expects, but states frankly, at the beginning, that more or less of deformity, and impairment of function, may be the final result.

This want of adaptation of the means to the end is, at first sight, somewhat surprising. To insure success, the indications themselves are few and simple. They are mainly twofold : first, to reduce the fragments ; and, secondly, to maintain them in apposition until they are firmly united. Simple as these indications are, however, they are equally difficult to fulfil. As far as the bones are concerned, the problem is purely me-

chanical; and, if we had to deal with these alone, our task would be an easy one. In applying force, however, for the reduction and coaptation of fracture, we always act at a disadvantage, owing to the intervention of the more delicate soft parts that invest the bone. It is in consequence of the presence of these, to the influence which they exert in causing displacement, and to the injury to which they are liable, either at the time of fracture, or subsequently, from the pressure of the retentive apparatus, that the results of treatment are so often imperfect and unsatisfactory. By investing, more or less completely, the ends of the broken bone, they interfere, to a corresponding degree, with accuracy of diagnosis and nicety of adjustment. The muscles not only conceal the injured bone, but, by their spasmodic contraction, act powerfully in causing displacement of the fragments. The skin and subcutaneous connective tissue, moreover, not unfrequently suffer from the pressure or traction of the dressings; and the consequent supervention of pain, oedema, or excoriation, may compel the surgeon to remove them, thereby compromising the result, by leaving unopposed the forces which produce displacement.

These obstacles to success being appreciated and acknowledged, it becomes our duty to inquire how far they may be lessened, if not wholly removed; and whether, among the different modes of treatment commonly pursued, any one of these can claim superiority. Such comparisons, however, are not easily made. They require the study of a large number of cases, which can be found only in the wards of a large hospital. Yet, even here, there is a tendency in favor of routine plans of treatment, sanctioned by long-established usage, and by increasing technical skill in the employment of a particular method. Thus, while in one hospital we find all fractures of the leg treated in the so-called fracture-box, in another we look in vain for such an apparatus. In one hospital, nearly every fractured leg or thigh is suspended, while in another this plan of treatment is, perhaps, unknown.

My object, in the present paper, is to embody the results of the treatment of fractures, on a somewhat extensive scale, by the plaster-of-Paris bandage, at the Bellevue Hospital, dur-

ing the past eighteen months ; and at the same time to discuss a few points relative to the general treatment of fractures, which are perhaps not yet definitely settled. My experience has led me to the conviction that the mode of treatment just referred to possesses advantages which are enjoyed by no other one in general use ; and, although the method is not novel, it has not obtained, I think, from American surgeons, the careful and thorough trial which it deserves.

The remarks I am about to make relate to simple fractures, although the report includes, as will be seen, a few instances where the fracture was compound.

Supposing a fracture to come under the surgeon's care soon after it has occurred, the question arises, whether its reduction should be at once effected. At the present day, this question must be answered affirmatively. In former times it was maintained that, inasmuch as a week or ten days must elapse before the commencement of the reparative process, it would be useless to attempt immediate reduction, which, moreover, could then be accomplished only imperfectly, or with great difficulty, on account of the spasmodic contraction of the surrounding muscles. Another assumed reason for delay was founded upon the prevailing belief that a fracture was pretty sure to be followed by such an amount of inflammation and swelling of the injured parts, that, even if early reduction were practicable, the apparatus necessary for preserving the fragments in coaptation could not be applied without annoyance, and even danger, to the patient.

Now, none of these arguments will be found valid, on careful examination. It is true that the formation of callus in fracture does not immediately follow the accident ; but it begins at a much earlier period than was formerly supposed, and takes place most rapidly in young subjects, and when the smaller and more vascular bones are fractured. It has also been definitely ascertained that the production of callus from the *ends* of the fractured bone is both facilitated and accelerated by reduction at an early period. As long as the fractured surfaces are not in contact, they take little or no part in the work of repair.

In regard to the time when reduction can be most easily

accomplished, I think a brief consideration of the causes of displacement will show that the earlier an attempt is made, the greater will be the chances of success. One among the more unusual causes of displacement is impaction of the fragments. Here there can be no doubt that, if reduction is to be effected at all, it can be performed as well immediately after the injury as at any subsequent period. It may be observed, however, that, in certain cases, it is impossible to disengage the fragments, without exposing them by dissection; and that, in other cases, reduction ought not to be attempted. Examples of the latter class are found in fracture of the spine, and in impacted fracture of the neck of the thigh-bone.

Serious difficulty in reduction sometimes arises from the interposition of a piece of muscle or fibrous tissue between the fragments, one of the latter having perforated the soft parts, but without injuring the skin. In a case of fractured clavicle, due to direct violence, I once saw the inner fragment driven through the trapezius muscle, where it was firmly retained until I released it by the knife. Similar causes sometimes prevent reduction in fracture of the lower end of the shaft of the femur, where the upper fragment perforates the rectus muscle, and in fracture through the surgical neck of the humerus; the tissues, in this case, being perforated by the lower fragment. In any of these instances, the constricting parts may sometimes require to be divided, to render reduction practicable; and in all it is evident, that, whatever means be resorted to, should be used without delay, and before the occurrence of inflammation.

In certain cases, again, we are unable to control the fragments, on account of their situation. In fractures of the ribs, the sternum, the bones of the pelvis, and the neck of the femur within the capsular ligament, we can seldom employ with success the mechanical means which we find so useful elsewhere.

Leaving, now, these less frequent causes of displacement, and confining our attention mainly to fracture of the long bones, we find that the contraction of the voluntary muscles constitutes the chief obstacle to reduction. If any evidence is needful to prove the truth of this statement, we have only

to examine a case of recent fracture of either the humerus or femur, near the middle of the shaft. Here we can both see and feel the rigid muscles contracting beneath the skin, thereby causing shortening and deformity of the injured limb. In many instances of fracture, the very kind of deformity may be predicted, by calculating the relative strength of the muscles situated on the different aspects of the broken bone. In fracture of the olecranon, or coronoid process of the ulna, and in fracture of the patella, no one will deny the agency of the muscles in causing displacement.

It is equally easy to prove that the deformity due to muscular contraction will be most likely to be corrected, if the extending force be applied immediately after the accident; whereas, if the attempt is not made until some days later, the shortening of the muscles will have become more or less permanent; and the infiltration of these and the neighboring soft parts with the products of inflammation will render the efforts at reduction more difficult, and not altogether free from risk.

In fractures, as in dislocations, our practice has undergone great changes since the introduction of anæsthetics, by the administration of which we are generally able to bring about a complete relaxation of the opposing muscles. As far as these are concerned, therefore, it may be taken for granted that their resistance can be neutralized, and that, consequently, a satisfactory adjustment of the parts may be secured. In dislocation, the success thus obtained is not only immediate, but permanent. In fracture, on the contrary, the tendency to displacement recurs as soon as the patient has recovered from the effects of the anæsthetic; and it is requisite, not only to restore the fragments to their proper relations, but to maintain them in apposition until they are organically united. This is the vital point in the management of fracture. To reduce the fracture is usually practicable, and oftentimes easy; but is it possible to apply a dressing that shall maintain the coaptation of the fragments during the requisite period, and, at the same time, do no violence to the soft parts? That the fulfilment of this double indication is a difficult problem, is evident from the endless variety of apparatus recommended by surgical authorities for the treatment of fracture. It will be admitted, how-

ever, that the value of every such appliance must be measured, first, by its mechanical efficiency ; and, secondly, by the comfort and safety with which it can be worn. Unless it meets both these requirements, it will not answer our wants. Now, it will be found, I think, on examination, that the plaster-of-Paris bandage fulfils these important indications more effectually than any other mode of dressing yet devised. In other and less essential particulars, also, it possesses advantages which should not be overlooked, while drawing a comparison between this and other plans of treatment.

In all the cases herewith reported, the plaster-of-Paris bandage was applied according to the method originally recommended by the Dutch surgeon, Mathijsen, in 1852. As consider this method greatly superior to that advocated by Pirogoff, which found favor at the New York Hospital some few years ago, I may be pardoned for describing it in detail.

The bandages are prepared in the following manner. A piece of soft, coarse, unbleached muslin is torn up into strips, about three yards in length, and varying in width from one to three inches, according to the thickness of the limb. Some freshly-prepared, dry plaster of Paris having been spread upon a table, it is then rubbed thoroughly into the meshes of the bandage on both its surfaces, sufficient plaster being applied to conceal the texture of the muslin from view. The bandages are next loosely rolled up, and kept in a dry place until needed for use. Before applying them in cases of fracture, the following precautions are observed : The fracture having been reduced, the limb is covered by a layer of cotton or woollen batting ; or, if these materials are not at hand, by a single thickness of old, soft blanket. Over this is applied a cotton, or what is still better, a flannel roller, care being taken to have the pressure gentle and uniform, and not to constrict the limb at any part. The plaster-of-Paris bandages, which have previously been immersed in water for about three minutes, are then put on, in sufficient number to secure the desired degree of firmness. About three layers of the bandage are usually adequate to the object in view. The bandage is to be laid on evenly and snugly, but uniformly, and without compressing the limb ; and

it is not necessary to avoid reversed turns, as has been stated by some authors. In a short time after the bandage has been applied, the plaster sets, and the dressing is then complete.

The plaster, when of good quality, hardens in about ten minutes; the maximum degree of firmness, however, is not reached until one or two hours later, when, the water having evaporated, the bandage dries and acquires an almost stony hardness. If, after the bandage has been applied, a mixture of plaster of Paris and water, of the consistence of cream, be evenly rubbed with the hand over the surface, the latter will become smooth, and elegantly polished; but, if an excess of plaster is applied in this manner, it will render the dressing exceedingly brittle, and liable to crack and crumble after it has been worn for a short time. When the proper proportions of plaster and muslin are hit upon, the bandage has a certain degree of elasticity, and the requisite firmness is obtained, without undue bulk or weight.

Experience has also shown that attention should be paid to the following points: the muslin selected for bandages should have the proper degree of thickness, and should be neither too fine nor too coarse. If too fine, its meshes will not receive the plaster, and, if too coarse, they will not retain it. The plaster should be very fine, such as is used by modellers, from whom it may conveniently be procured. The coarser varieties ought to be rejected as unfit for surgical use. Great care must be taken to maintain accurate coaptation of the fragments, during the time the bandage is being applied, and subsequently, until it becomes firm.

When it is desired to remove the bandage, this may readily be done by cutting it through its entire length, with the point of a stout, sharp knife, directed somewhat obliquely. The bandage cannot be removed, however, without losing, to a certain degree, its firmness. In cases, therefore, where it becomes too loose, in consequence of the subsidence of swelling a few days after it has been applied, it is best to remove it altogether, and replace it by a new bandage.

In the cases presented, the extent to which the injured limb was enveloped by the bandage varied, although, in every instance, the flannel or muslin bandage, together with the pad-

ding next the skin, was employed from the hand or foot upward beyond the seat of fracture. In fracture of the forearm, the bandage was carried from the hand to the elbow; and in fracture of the olecranon, to the upper part of the humerus. In fracture of the humerus, the bandage extended from the hand to the shoulder, the latter joint being capped by a spica. Where the bones of the leg were broken, the bandage was made to surround the limb as high as the knee, this joint being generally left free. In fracture of the patella, in addition to the plaster-bandage, the approximation of the fragments was promoted by compresses of lint, placed above and below the broken bone. In private practice, I have, in this fracture, adopted a somewhat different method, and with excellent results. Previous to applying the plaster-bandage, I have drawn the fragments together by two broad strips of adhesive plaster, fastened upon the front of the leg and thigh, and buckled over the top of the injured bone. The plaster-bandage then being applied from the toes to the groin, a large fenestra was cut opposite the seat of fracture, in order to permit inspection of the fragments, and their further approximation, if necessary, by the bands of adhesive plaster.

The cases presented in this paper were all treated in the Bellevue and Centre Street Hospitals, within the past eighteen months, and care has been taken to collect all the cases found in the hospital records. They occurred partly in my own wards, and partly in those of my colleagues, and the house-surgeons have shown a commendable zeal and diligence in perfecting the application of the bandage. I am indebted to Dr. Samuel St. John, one of the house-surgeons, for many of the details contained in the report.

The whole number of cases treated was ninety-three. Of these seven were fractures of the forearm, seven of the humerus, three of the patella, fifty-three of the bones of the leg, and twenty-three of the femur. Firm union was obtained in all cases except one, and in this, a case of fracture of the leg, the patient had well-marked constitutional syphilis. In many instances, the bandage was applied within a few hours after the injury; in others, not until after the lapse of from ten days to a fortnight. In a minority of cases, and whenever necessary,

ether was administered to facilitate the coaptation of the fragments. In many of the cases, especially in the earlier ones treated for oblique fracture of the bones of the leg, the plaster-bandage was slit up on the third or fourth day, and reapplied, as is done with the starched bandage. This precaution was taken, in order to ascertain whether the displacement had recurred; but, in nearly every case, the fragments were found in good position, and of late such a precaution has not been deemed essential. In a few instances the bandage became loose from the subsidence of swelling; it was then removed, and replaced by a new one.

How soon after a fracture can the plaster-bandage be applied without risk? This point is one of great importance, and one concerning which much diversity of opinion prevails, although the majority of surgeons, I think, condemn the use of closely-fitting dressings before the subsidence of the inflammatory swelling which so often occurs a short time after the injury. It is obvious, however, that the early application of the bandage must be of great advantage, unless it can be shown that such a practice is dangerous. To investigate this point, I have selected for special study those cases in which the bandage was put on within the first seven days following the fracture; omitting, however, for the present, any reference to fractures of the femur, which I have reserved for separate consideration.

It may be proper to remark that the cases in the following table were not chosen for the early application of the plaster-bandage, because the injury was of slight degree. For some time, it was chiefly a matter of convenience whether the bandage should be applied at once, or the limb be permitted to remain for a longer or shorter time in a fracture-box, or some other temporary apparatus. For the past two months, however, not a single fracture-box has been employed in my hospital wards. (See table, p. 12.)

The facts above given are sufficient to show, that, in a great many cases, the plaster-bandage may be applied to a fractured limb, either immediately, or very soon after the accident, without the danger of injurious consequences. This practice, however, is deprecated by most surgical authorities, who

| | | | | RESULT, ETC. |
|--|-----------------------|-----------------------|-----------------------------|---|
| | | Shaft of Humerus. | Seat of Fracture. | |
| | | | Number of Cases treated. | Plaster-Bandage, when applied. |
| | | | 3 | 2d day. |
| | | | | Firm union and good position. In one, the fracture was very oblique, and forcible extension was necessary while plaster hardened. Union occurred in 5 weeks, 4 weeks, and 5 weeks, respectively. |
| | | | 1 | 4th day. |
| | | | | Union in 24 days—no deformity nor stiffness. |
| | | | 4 | 1st day. |
| | | | | No. 1. Deformity marked on admission. Firm union in 4 weeks. Position perfect. No. 2. Deformity slight on admission—union in 5 weeks—good position. No. 3. Deformity great, and not entirely reducible—union in 5 weeks, with slight deformity. No. 4. Deformity marked, but reducible—union in 24 days—no deformity nor stiffness. |
| | | | 1 | 3d day. |
| | | | | Great deformity, not wholly reducible—union in 6 weeks, with some deformity and considerable stiffness of fingers and wrist. Average period of union, 33 days. |
| | | | 1 | 3d day. |
| | | | | Union in 4 weeks, by a ligament $\frac{1}{8}$ inch in length |
| | Tibia and Fibular. | Olecranon Process. | 5 | 1st day. |
| | | | 2d " | " " " |
| | | | 3d " | " " " |
| | | | 1st " | " " " |
| | | | 5th " | " " " |
| | | | 6th " | " " " |
| | | | 7th " | " " " |
| | | | | Firm union, in good position. { In one, deep extravasation, and circumference of injured limb, one-third greater than that of sound one. Plaster-bandage, 4 hours after accident. Patient on crutches next day. Union in 12 weeks. In one, fracture very oblique, the upper fragment projecting. Average—union in 6 weeks. |
| | Tibia. | | 2 | 1st day. |
| | | | 4th " | " " " |
| | | | 5th " | " " " |
| | | | 6th " | " " " |
| | | | 7th " | " " " great swelling and ecchymosis. Average—union in 5 weeks. |
| | Fibula. | | 1 | 1st day. |
| | | | 2d " | " " " |
| | | | 3d " | " " " |
| | | | 7th " | " " " Average—union in 5 weeks. |
| | Pott's Fracture. | | 1 | 1st day. |
| | | | 2d " | " " " |
| | | | 3d " | " " " |
| | | | 4th " | " " " |
| | | | 5th " | " " " |
| | | | 6th " | " " " Average—union in 5 weeks. |
| | Patella. | | 1 | 4th day. |
| | | | | Union by ligament $\frac{1}{8}$ inch long. In fracture of the patella, the plaster-bandage can rarely be employed during the first week, as the effusion in the knee-joint is generally sufficient to prevent the close approximation of the fragments. |

assert that in no instance should tight dressings be resorted to until the inflammatory swelling has subsided; and cases in which gangrene of the limb has resulted from a neglect of this precaution are solemnly held up to us as a warning. Now, in this matter, as in many others, the truth lies between extremes. Having myself witnessed the occurrence of mortification from overtight bandaging, I am prepared to admit its disastrous consequences. But, a valuable method of treatment ought not to be condemned because the bungling employment of it is attended with risk. On the same principle we might denounce the pressure-treatment of aneurism, which, in skilful and cautious hands, has yielded such brilliant results. That the danger of gangrene has been greatly exaggerated, must be apparent from the fact that no such unpleasant consequence happened in any of the cases enumerated above. In truth, the timely application of moderate and uniform compression to the broken limb, so far from doing harm, is of the greatest service, by repressing the inflammatory swelling which, under the usual treatment, is so apt to occur. When a plaster-bandage is applied in a case of recent fracture, it further diminishes the chances of inflammation, by keeping the fragments in nearly exact coaptation; while, under the usual plan of treatment, displacement is tolerably sure to recur, giving rise to renewed irritation of the soft parts. Those who have treated, for example, an ordinary, simple fracture of the leg in a fracture-box, must acknowledge how much attention is daily required to preserve the fragments in place. However well the foot be fastened to the foot-piece, and however carefully the box be padded, a slight loosening of the dressings, or an incautious movement of the patient in bed, will often permit separation of the fragments, thus causing pain and irritation, and rendering necessary the further application of force to the already over-sensitive limb. These accidents are obviated by the plaster-bandage, which, when applied immediately after a fracture, surrounds the injured parts with an unyielding, accurately-fitting case, and efficiently secures the apposition of the fragments.

I maintain then, that, in almost every case of simple fracture, an immovable apparatus should be applied at the earliest

practicable moment—if possible, immediately after the accident. Should inflammatory swelling or extravasation exist, the bandage may even then be used with advantage, care being taken to avoid undue pressure by placing an additional layer of cotton-wadding next the skin. The only cases in which I should consider its employment dangerous, are those in which gangrene seemed imminent, or in which erysipelatous or phlegmonous inflammation was in progress. Under such circumstances, the application of a tight dressing would obviously be inappropriate.

In fractures of the lower extremity, the treatment here advocated enables the patient to leave his bed, and to go about on crutches during the entire period of cure. The advantages he thereby enjoys, both in point of health and comfort, are too apparent to require further comment.

It has sometimes been stated that the early use of immovable dressings in fracture is objectionable, because the pressure interferes with the formation of callus, and in this manner increases the risk of a false joint. Billroth, who employs the plaster-of-Paris bandage, admits that union is often delayed, and endeavors to account for the delay by the fact that, where accurate coaptation is maintained from the beginning, the production of provisional callus is very limited. The permanent callus, it is true, forms in due time; but as its formation takes place naturally at a later period, the mobility of the fragments continues for a corresponding length of time.

The figures given above render it doubtful, I think, whether any delay in consolidation is fairly chargeable on the method of treatment employed. In the cases tabulated, the average period of union will compare favorably with that usually observed; and, in the case where union was deferred to the twelfth week, the delay was probably due to a large, deep-seated extravasation.

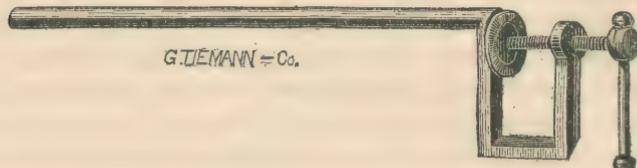
Delayed union was also observed in two cases of fracture of the leg, not mentioned in the table. In one of these, the plaster-bandage was applied on the twelfth day, and in the other on the fourteenth day. In the first case, the patient left the hospital at the end of the eighth week, with the fracture only imperfectly united, although he was able to use the leg in

walking. In the other case, firm union occurred after the lapse of six months. Both of these patients had constitutional syphilis.

Finally, I desire to speak briefly of the treatment of fracture of the thigh-bone; and, in so doing, I fear that I am treading on dangerous ground. The method advocated by Dr. Buck, consisting principally of the attachment of a weight to the foot, to overcome the contraction of the muscles, is so simple, and has borne such satisfactory results, as to leave little or nothing, perhaps, to be desired. Nor have I aught to say in disparagement of this plan of treatment. But I find the use of the plaster-bandage as efficient here as in other cases, and accompanied by the same advantage as in fracture of the leg; namely, that of allowing the patient to get out of bed, and to go about on crutches during the period of cure. I resorted to this method at first with some apprehensions as to the result, and I have been agreeably disappointed. Fracture of the femur is very justly regarded as the one in which shortening and deformity of the limb are most likely to occur from muscular contraction; for no other bone is surrounded by such thick and powerful muscles as this one. Indeed, the tendency to shortening in this fracture is so marked that, in adults, a restoration of the limb to its previous length is an exception to the rule. The cases here given, therefore, while they show the applicability of the method of treatment described in this paper to fracture of the femur, may also be fairly adduced in evidence of its reliability as a means of retention in fractures generally. In other words, the plaster-of-Paris bandage finds its severest test in fracture of the thigh-bone.

The mode of applying the bandage in fracture of the femur is essentially the same as that followed in other cases. It is necessary, however, in some instances, to use considerable force in extending the limb to its normal length; and, if manual extension prove insufficient, the compound pulleys afford a safe and convenient means for accomplishing this object. They may be attached to the body by a piece of stout adhesive plaster, which, having been bandaged to the sides of the leg, projects beyond the sole of the foot in the form of a loop. An anaesthetic is not required in every case, but, in many, the

assistance which it affords cannot be dispensed with. For the purpose of making counter-extension, I employ, in all cases, an iron bar, similar to the one recommended by Volkmann,



and for which an ordinary perineal band is a very indifferent substitute. This bar is so fastened as to rise vertically from the table on which the patient is placed during the adjustment of the bandage. Before being used, it should be covered with cotton, or any other soft material, to prevent injury to the perineum. The patient having been placed astride of the bar, and ether administered, if necessary, sufficient extension must be made to bring the limb out to its proper length ; the plaster-bandage should then be applied from the foot to the groin, and also around the pelvis in the form of a stout spica. It is while effecting this manœuvre that the use of the iron bar in the perineum proves so serviceable. The patient can be lifted from the table by a couple of assistants, while the bandage is passed beneath the pelvis ; counter-extension being, at the same time, effectually maintained.

During the application of the bandage, and until it has become firm, pains should be taken to preserve the proper length and position of the limb. In some of my own cases, extension was kept up for several hours after the bandage had been applied, by a weight of ten or fifteen pounds, suspended by a cord running over a pulley at the foot of the bed, the cord being attached to a loop of adhesive plaster in the usual manner. Especial care should be taken, also, to pad the perineum evenly and thickly, either with cotton-wadding or with pieces of soft blanket, previous to applying the plaster-bandage. Unless this is done, the apparatus will not be worn with comfort, and the perineum will be liable to excoriation. That part of the bandage which surrounds the hip and pelvis should be very strong ; otherwise it is apt to give way at the flexure

of the groin. Sometimes it is well to afford additional strength in this situation by a piece of felt, or sole-leather, of suitable size and shape, over which the turns of the spica may be carried.

If properly applied, the plaster-bandage is, in my judgment, better calculated to prevent motion between the fragments than any other dressing yet invented. The hip-joint is securely held, and displacement at the seat of fracture is almost impossible, as the entire lower extremity, including the corresponding side of the pelvis, must move together as a whole. Owing to the immobility of the hip-joint, the sitting posture is inadmissible; but the patient can recline upon a sofa, or easy-chair, and may be allowed to go around the room on crutches. He can also readily change his position in the bed, and raise the body to receive the bed-pan.

Applied in accordance with the foregoing rules, the plaster-bandage has been used in twenty-three cases of fracture of the femur, two of which were compound. The following abstract of the cases has been prepared from the hospital records:

CASE I.—Bernard Reynolds, aged eighteen months. Fracture through middle of shaft, caused by the passage of a cart-wheel. Plaster-bandage on day following fracture. Bony union in five weeks. No shortening.

CASE II.—Edward Murray, aged three years. Fracture through middle of shaft, from the kick of a horse. Shortening, on admission, one inch. Reduction without ether; plaster-bandage on fifth day. Splint removed in six weeks. Union firm; shortening, one-quarter of an inch.

CASE III.—William Moss, aged four years. Fell twenty-five feet, fracturing right femur at middle. Shortening, on admission, an inch and a quarter. Plaster-bandage same day. During treatment, patient disobeyed orders, and walked about the hospital ward without crutches. Union in five weeks. Shortening, one-quarter of an inch.

CASE IV.—James McNamara, aged seven. Fracture through shaft, at junction of middle and upper thirds. Considerable swelling of thigh, and effusion into knee-joint. Plaster-bandage second day. Removed in six weeks. Firm union; no shortening.

CASE V.—William Suppron, aged nine. Fracture of shaft, caused by the wheel of an omnibus. Bandage applied on second day. Manual extension under ether. Union in five weeks. No shortening.

CASE VI.—John Murphy, aged ten. Two hours before admission, his femur was broken near its middle, by the wheel of a cart. Plaster-bandage on seventh day. Union in six weeks. Shortening, three-eighths of an inch.

CASE VII.—Edward Mills, aged fourteen. Fracture through middle of shaft. Shortening, one and a quarter inch. Plaster-bandage, under ether, on third day. Union in six weeks. Shortening, one quarter of an inch.

CASE VIII.—Patrick Ford, aged twenty-eight. Fell from a horse and fractured right femur, at junction of middle and lower thirds. Shortening, three-quarters of an inch. Plaster-bandage on second day, with ether and manual extension. Union in six weeks. No shortening.

CASE IX.—Peter Sloll, aged thirty-two. Fell twenty-three feet, fracturing shaft of left femur. Extension by weight and pulley for eleven days, when plaster-bandage was applied. The bandage caused excoriation of the perinæum, and was removed on the sixth day. Bony union occurred, but time not stated.

CASE X.—Patrick Menel, aged thirty-three. Fracture at middle of shaft. Shortening, one and a quarter inch. Plaster-bandage on following day. Ether, and manual extension. Firm union in six weeks. No shortening.

CASE XI.—Thomas Fitzgibbons, aged sixteen. Left femur at middle. Shortening, one inch. Put up in plaster-bandage on third day. Ether, and manual extension. Union in six weeks. Shortening, one-eighth of an inch.

CASE XII.—Adam Beck, aged forty-three. Oblique fracture through middle of shaft. Shortening, one inch, and thigh greatly swollen. Plaster-bandage on third day. Ether, and compound pulleys. On seventeenth day, the bandage, having become loose from the subsidence of swelling, was removed as far down as the knee, and extension made by weight and pulley. On twenty-fourth day, bandage pieced out from knee upward. Union in six weeks. Shortening, one-eighth of an inch.

CASE XIII.—Was a case of refracture. Samuel Loderer, aged eighteen, entered the hospital with fracture of femur near middle of shaft. Was treated by weight and pulley for four weeks, when there was some union, with one-quarter of an inch shortening. Patient got out of bed and refractured the bone. Plaster-bandage on third day. Union in five weeks. No shortening.

CASE XIV.—Samuel Ranschenburg, aged sixty-three. Compound fracture at junction of middle and lower thirds—and fracture of bones of leg on same side, also an old irreducible luxation on dorsum ilii. Bandage on fourth day. Union in eight weeks. Slight anterior displacement of upper fragment. Owing to old dislocation, the length of limb could not be ascertained.

CASE XV.—Patrick Donnelly, aged nineteen. Fracture of shaft at upper third. Shortening, one and a half inch. Extension by weight and pulley till eighth day, when plaster-bandage was applied. Ether, and manual extension. On eleventh day, abdominal part of bandage removed. Union in seven weeks. No shortening.

CASE XVI.—F. Page, aged thirty-three. Fracture at junction of lower and middle thirds. Shortening one and three-fourths of an inch. Band-

age on fifth day. Union in seven weeks. Shortening, one quarter of an inch.

CASE XVII.—Patrick Rounds, aged thirty-two. Fracture through lower third. Shortening, one-half inch. Bandage applied under chloroform on third day. Union in seven weeks. No shortening.

CASE XVIII.—Joseph Williams, aged thirty-three. Fracture just below lesser trochanter. Shortening, one and a quarter inch. Bandage on thirteenth day. Union in nine weeks. Shortening, one-quarter of an inch.

CASE XIX.—Compound fracture. James Hamilton, aged forty-five, had his thigh caught between a coal-box and the end of a cart, two hours before admission. At lower part of Scarpa's space, and just external to femoral artery, was an opening an inch and a half in length, through which two fingers could be introduced, down to the ends of the broken bone. Fracture oblique, the upper fragment being strongly tilted forward. Plaster-bandage applied immediately, without ether. The leg and thigh were flexed, and bandage applied in that position. A fenestra was cut, to expose wound, which was dressed with oakum. Union in seven weeks. Shortening, three-quarters of an inch.

CASE XX.—Christian Schneider, aged fifty-five. Fracture of cervix femoris, supposed to be extra capsula. Shortening, one and a half inch. Ether, pulleys, and plaster-bandage, on fourth day. Union in eight weeks. Shortening, three-eighths of an inch. Patient walks without assistance.

CASE XXI.—Peter Oest, aged sixty. Fracture of right cervix femoris, extra capsula. Shortening, one and a quarter inch. Ether, pulleys, and plaster-bandage, on fifth day. Union in seven weeks. No shortening.

CASE XXII.—David Dready, aged sixty-three. Cervix femoris. Shortening, one and a quarter inch. Plaster-bandage on fourth day, with ether and pulleys. Union in seven weeks. Shortening, three-quarters of an inch. Patient walks without assistance.

CASE XXIII.—Thomas Callahan, aged forty-five. Fracture through great trochanter. Shortening, two inches. Ether, pulleys, and plaster-bandage, on third day. Union in seven weeks. Shortening, one inch. Good motion at hip-joint.

An analysis of the cases above narrated affords the following results :

In eighteen out of twenty-three cases the bandage was applied within six days from the time of the injury. An anaesthetic was found necessary to permit reduction in eleven cases.

In one case, the bandage caused excoriation of the perineum, and was removed. In no other instance was the bandage removed till bony union had taken place.

In one case (No. XIV.), although union was firm, the presence of an old dislocation prevented the length of the limb from being accurately measured.

The remaining cases, twenty-one in number, I have arranged in the following tables:

| | <i>Result.</i> | | | | | | | | |
|--|---|------------------|----------|----------------|---------------------|----------------|-----------------|--------------------|-----------------------|
| Under fifteen years of age, seven cases. | <table border="0"> <tr> <td>No shortening in</td><td style="text-align: right;">2 cases.</td></tr> <tr> <td>Maximum "</td><td style="text-align: right;">$\frac{2}{3}$ inch.</td></tr> <tr> <td>Average "</td><td style="text-align: right;">$\frac{1}{3}$ "</td></tr> <tr> <td> " period of union,</td><td style="text-align: right;">$5\frac{1}{2}$ weeks.</td></tr> </table> | No shortening in | 2 cases. | Maximum " | $\frac{2}{3}$ inch. | Average " | $\frac{1}{3}$ " | " period of union, | $5\frac{1}{2}$ weeks. |
| No shortening in | 2 cases. | | | | | | | | |
| Maximum " | $\frac{2}{3}$ inch. | | | | | | | | |
| Average " | $\frac{1}{3}$ " | | | | | | | | |
| " period of union, | $5\frac{1}{2}$ weeks. | | | | | | | | |
| Over fifteen years of age, fourteen cases. | <table border="0"> <tr> <td>No shortening in</td><td style="text-align: right;">6 cases.</td></tr> <tr> <td>Maximum "</td><td style="text-align: right;">1 inch.</td></tr> <tr> <td>Average "</td><td style="text-align: right;">$\frac{1}{3}$ "</td></tr> <tr> <td> " period of union,</td><td style="text-align: right;">7 weeks.</td></tr> </table> | No shortening in | 6 cases. | Maximum " | 1 inch. | Average " | $\frac{1}{3}$ " | " period of union, | 7 weeks. |
| No shortening in | 6 cases. | | | | | | | | |
| Maximum " | 1 inch. | | | | | | | | |
| Average " | $\frac{1}{3}$ " | | | | | | | | |
| " period of union, | 7 weeks. | | | | | | | | |

These figures, I think, are conclusive respecting the efficiency of the plaster-bandage, as a means of treatment for fracture of the femur. They prove that our notions in regard to the necessity of applying some special kind of apparatus for extension and counter-extension are to a certain degree, erroneous, and require modification. It is probable that, when a plaster-of-Paris bandage is applied in a case of fracture of the femur, the perinæum forms the chief seat of counter-extension. This view is supported by the fact that in one case (No. IX.) the perinæum became excoriated from the pressure of the bandage, and that in another (No. XV.), although all that part of the bandage situated above the groin was removed three days after it had been applied, yet recovery took place without any shortening of the limb. It is evident, however, that the disposition to shortening is principally obviated by the nice adaptation of the bandage to the injured limb, around which it forms an exact mould, corresponding with all of its prominences and depressions, and thereby rendering displacement well-nigh impossible. It is in consequence, also, of the equal distribution of the pressure exerted by the plaster-bandage, that it rarely gives rise to those abrasions of the malleoli and other salient points, which so often attend the employment of wooden and metallic splints.

The prompt recovery of two adult patients, in whom the fracture of the femur was compound, is worthy of remark, as such a result is rare under any plan of treatment. In one of these cases, where the fracture was situated at the upper part

of the shaft, and where the superior fragment was tilted strongly forward, satisfactory reduction was obtained by flexing the leg and thigh, the plaster-bandage being then applied to secure the limb in the flexed position. The precision with which it accomplished this object was equally striking and satisfactory.

In conclusion, the advantages of the plaster-of-Paris bandage in the treatment of fracture may be summed up in a few words. It affords a safe and reliable means for securing the fragments immediately after the accident, and in point of safety and efficiency it is far superior to the starched bandage, with which it is usually compared. It is safer, because it can be applied more evenly, and therefore with less risk of constricting the limb. Moreover, experiment has demonstrated that it undergoes no alteration in size or shape while drying ; on the other hand, the materials entering into the composition of the starched bandage either shrink or expand during this process, thus causing corresponding changes in the bandage itself. As a means of coaptation, it is more certain, on account of the rapidity with which it hardens, whereas the starch bandage remains more or less soft and yielding for a period of twenty-four hours. This property of the plaster-bandage enables the surgeon to make powerful extension, if necessary, to maintain the fragments in apposition till the bandage has grown firm, after which the limb may be left to itself without the danger of further displacement.

The security which the bandage affords is especially marked in cases of fracture occurring in restless children, in the insane, and in persons suffering from delirium tremens. Another advantage in these cases is derived from the fact that the bandage is not readily soiled or loosened by contact with fecal or urinary discharges.

The objections which are usually made to the practice I have advocated, need not detain us. It has been pronounced inefficient ; but this objection is fully answered by the marked success I have obtained in fracture of the femur, in which the causes of displacement are such as often to baffle our best exertions.

Again, it has been affirmed that the practice is hazardous,

and that in inexperienced hands it will be followed by disastrous consequences. It would be impossible for me to prove the negative; yet I have no hesitation in saying that, by attention to the simple rules which have been given, any student acquainted with the rudiments of minor surgery will, after one or two trials, succeed in applying the bandage as well as the most skilful expert. Should the occurrence of pain, however, or of blueness and numbness of the fingers or toes, indicate any impediment to the circulation, the expedient of slitting up the bandage is an easy one, which ought not to be neglected.

But the mistake which the young or inexperienced surgeon is most likely to commit is undoubtedly that of imperfectly reducing the fragments during the application of the bandage. If these are placed in accurate coaptation, the bandage will prevent displacement; but, if the displacement have not been corrected before the dressing is applied, or if it be allowed to recur before the latter becomes firm, union with deformity will be the inevitable result. In case, therefore, a doubt on these points should arise in the mind of the surgeon, he ought to open the bandage, and inspect the parts, before it is too late to remedy any possible defect. In cases where the fracture is very oblique, or the tendency to deformity very marked, it might be proper always to examine the parts, before complete consolidation has taken place. There is a time, when the callus has acquired a considerable degree of firmness, although it has not yet become hard and brittle, from ossification. If, during this period, any existing deformity be removed by suitable manipulation, very little external support is subsequently required, to obviate further displacement.

When I look back on the complicated and cumbersome mechanical contrivances which were recommended for the treatment of fracture when I was a student, and which many employ even at the present day, I cannot help thinking that the plaster-bandage is almost as great a boon to the surgeon as to the patient. By the aid of a few simple materials, such as it is always easy to procure, better results can be obtained than with the most expensive and complicated apparatus.

The plaster-bandage has also a wide and useful application

in the treatment of compound fractures, club-foot, and diseases of the joints. These topics, however, are beyond the scope of the present communication. My main object is to urge the general adoption of the bandage in the management of simple fracture, as I feel convinced that its introduction constitutes one of the greatest advances in the practical surgery of modern times.

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